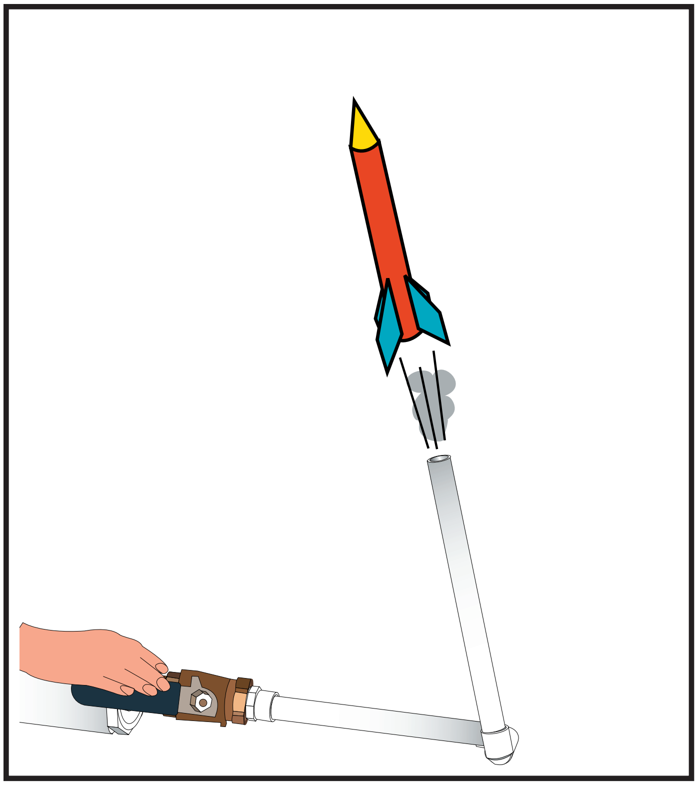


Rocket Activity

High-Power Paper Rockets

Objective

Construct and launch high-power paper rockets, evaluate their flights, and modify their design to improve flight performance.

Description

Students construct large paper rockets and test fly them using the high-power paper rocket launcher. Following their rocket's flight, students rethink their rocket designs, modify them, and fly them again to determine if their changes have affected the rocket's performance. Students conclude the activity by writing a post-flight mission report.

National Science Content Standards

Unifying Concepts and Processes
- Evidence, models, and explanation
- Change, constancy, and measurement

Science as Inquiry
- Abilities necessary to do scientific inquiry

Physical Science
- Position and motion of objects
- Motions and forces

Science and Technology
- Abilities of technological design

National Mathematics Content Standards
- Number and Operations
- Geometry
- Measurement
- Data Analysis and Probability

National Mathematics Process Standards
- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

Materials

High-Power Paper Rocket Launcher (see activity)
Bicycle pump with pressure gauge or small electric compressor
Paper 8 1/2 X 11" (white or color)
Cellophane tape
Ruler
Protractor
Scissors
1/2" PVC pipe 24" long
Student sheets

Management

Make sure that the rocket body tubes students roll are slightly loose. They should slide freely along the construction form tube. If not, it will be difficult to slide the completed rockets over the launch rod. Also make sure that students attach their nose cones securely to the body tubes.

Two sheets of paper are sufficient for making a rocket. If colored paper is used, students can trade scraps with each other to have different colored nose cones and fins.

Background

High-power paper rockets are merely a large version of the paper rockets constructed in the 3, 2, 1, Puff! activity presented earlier. The main difference is in how the rockets are launched. These rockets are propelled by the air rocket launcher constructed in the previous activity. A much more powerful blast of air is achievable than with lung power through a straw. The launcher is like an air-powered cannon. However, the rocket surrounds the launch rod (similar to a cannon barrel). High-pressure air fills the rocket. If the rocket were firmly attached to the rod, the nose cone and the forward end of the rocket would blow apart. Instead, the rocket begins sliding along the rod as it continues to fill with air. Immediately after clearing the end of the rod, air inside the rocket expands backward out the lower end. The action-reaction effect (Newton's third law) adds thrust to the already moving rocket.

If the rocket is well-designed and constructed, flights of more than 100 meters are possible. The primary determining factor for performance is drag or friction with the air. Rockets with very big floppy fins have a great amount of drag, and flights are usually short. Very squat nose cones also increase drag. The idea is to design a rocket that is streamlined so that it slices cleanly through the air. Through repeated flights, students discover that small and very straight fins are preferred along with long nose cones.

Tip Make sure students launch their rockets at the same angle and use the same pressure each time (experiment control).

Procedure Constructing the Rocket

1. Begin construction by rolling a cylinder of paper around the 1/2" PVC pipe. The paper can be rolled the long or short direction to make a tube 11 1/2" long or 8 1/2" long. Tape the seam.
2. Demonstrate how the nose cones are formed. Cut the half circle and curl its corners to form the cone shape. The round edge forms the base of the cone. The straight edge folds in the middle to form the apex as the sides overlap. Tape the seam.
3. Place the nose cone over the paper body tube (keep the PVC pipe inside for support). Fit the cone to the outside dimension of the body tube. Trim off the excess paper and tape the cone securely.
4. Cut rocket fins and tape them to the lower end of the body tube. The rocket is ready for launch.
5. Have students launch their rockets two or more times. Before the second launch, students should do something to modify their rockets to improve their flight performance. After their flights, they should record their observations on the mission report.

Discussion

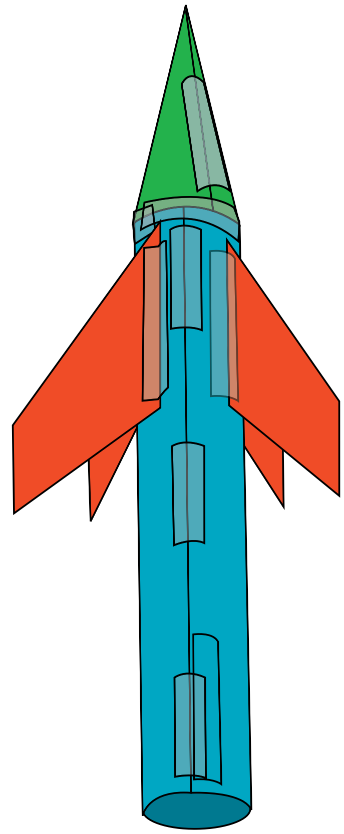
- *How can air rockets be modified to improve their flight performance?*
  There are several possible adjustments to the air rocket design. How loose or tight the tube is in relation to the launch rod affects air flow. The size and shapes of the fins affect air drag. Having fins mounted straight on the body of the rocket also affects drag. The length of the cone, squat or slender, affects how the rocket slices through the air.
- *Is it OK to change the fins and the nose cone at the same time?*
  Yes. However, it will not be possible to attribute improvements in flight performance to the changes that made a difference. Think of the design/redesign process as a controlled experiment where only one variable is changed at a time.

Assessment

- Review student mission reports and their conclusions.
- Have students write a paper explaining the principles of rocket flight as they apply to their paper rockets.

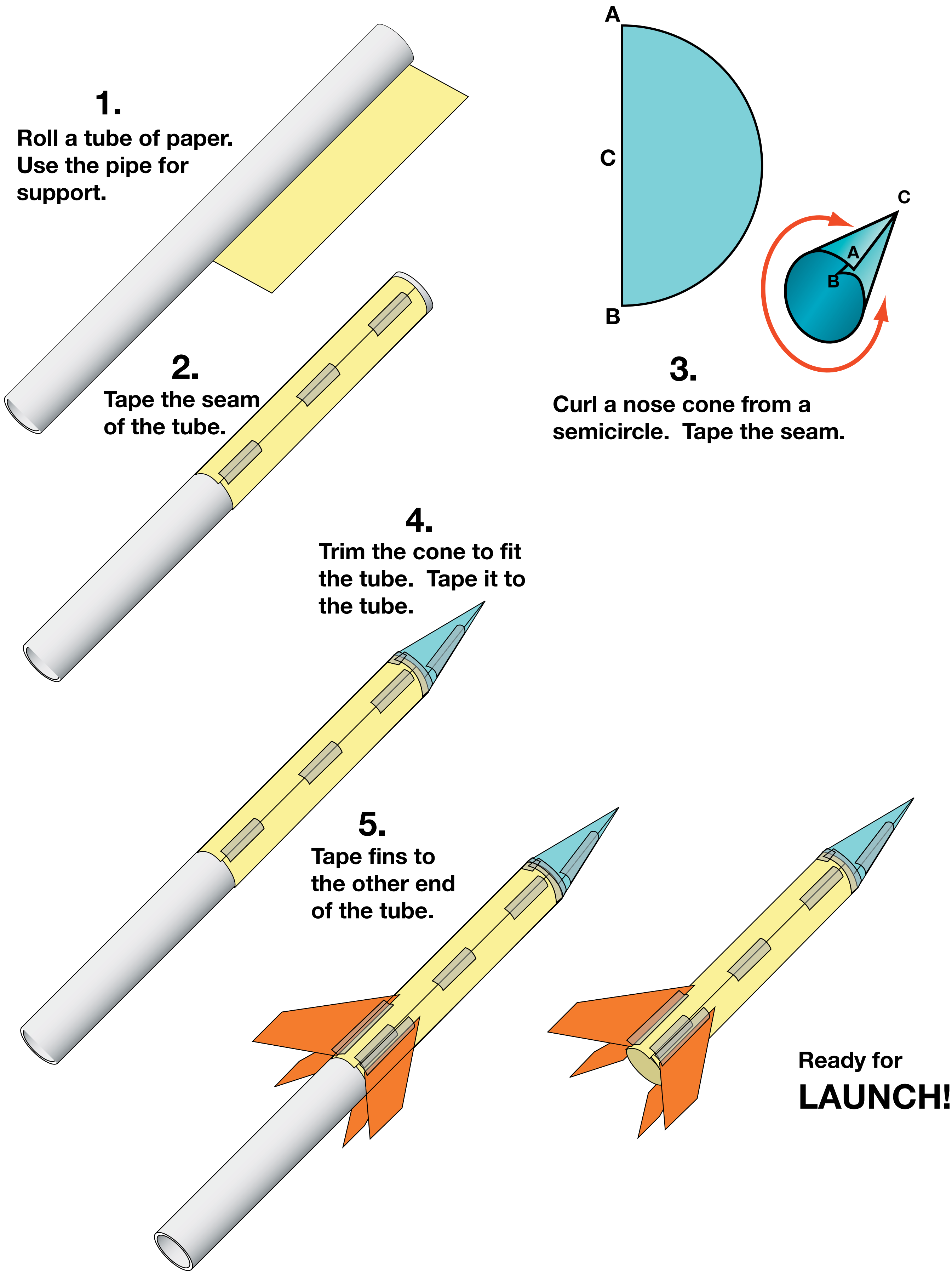
Extensions

- Have students draw one to three imaginative air rocket designs and speculate on how they would perform in flight. Have them build one of their designs and test it.
- Investigate fin placement on air rockets. Have students construct a new rocket but place the fins in different locations such as near the nose cone. Have them test the rockets and discuss their performance.
- Have students personalize their rockets with colored markers.



How well will a rocket designed like this fly?

Making a Basic High-Power Air Rocket



Air Rocket Mission Report

Name: ____________________________

Final Rocket Design

Test Flight 1 Summary:

Body Tube Length: __________ cm

Nose Cone Length:__________ cm

Number of Fins:_____________

Area of 1 Fin: ______________ square cm

How far did the rocket travel? ____________________

Describe the flight of the rocket. (Did it fly straight, wobble, drop quickly to the ground, etc?)

Test Flight 2 Summary:

Body Tube Length: __________ cm

Nose Cone Length:__________ cm

Number of Fins:_____________

Area of 1 Fin: ______________ square cm

What did you do to improve the rocket?

Predict how far the rocket will fly. _________________

Describe the flight of the rocket.

How far did the rocket travel? ____________________

Did your improvements work? Why or why not?

Rocket Fin Design

Design your fin on the first graph. Estimate its area by counting the number of whole squares it covers. Look at the squares partially covered. Estimate how many whole squares they are equal to. Add the two numbers together.

Area =

____

square cm

Redesign your fin.

Area =

____

square cm